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RICE MECHANISATION IN THE FEDERATION OF MALAYA

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THE Department of Agriculture's investigations into the mechanisation of padi have been described from time to time in the *Malayan Agricultural Journal* and the progress made was summarized in a paper presented to the Fourth Session of the International Rice Commission (2). The purpose of the present paper is to describe the objects of the investigational programme and to discuss the more important field trials which have been completed since the Tokyo meeting: reports on these trials have not, at the time of writing, been published and the information presented has been drawn from draft papers and unpublished Departmental reports.

INVESTIGATIONS INTO THE MECHANICAL CULTIVATION OF WET PADI

The use of tractors for rice cultivation was considered in Malaya before the War (8) and field trials were held as early as 1922 (7) but it was not until 1948 that the increasing cost of labour and the serious shortage of rice justified the inauguration of a comprehensive programme of investigations by the Department of Agriculture (9). This programme, which has been revised and modified from time to time in the light of experience, may be considered as two separate phases, although there was no formal distinction between these phases.

During the first phase, which lasted until 1953, attention was mainly focussed on the agronomic aspects of mechanisation since it was hoped that the more thorough cultivations made possible by applying greater power to implements would raise yields, and thus increase the production of surplus rice in the existing padi areas in the Federation, and that the greater speed at which operations could be performed with the help of machines would allow two crops of padi per year to be grown in certain areas. Because the main object of investigations during this phase was to increase yields and hasten cultivation, scant attention was paid to the mechanisation of operations, which did not influence the environment of the crop but much ingenuity and effort was devoted to the modification of mass–produced tractors and implements to enable them to be used in the small, swampy fields which are found in the padi areas of the Malay Peninsula.

The results of the agronomic investigations carried out during this phase of the programme were not encouraging and it was clear formidable technical and social problems would have to be overcome before mechanisation could be introduced into existing padi areas and that the immediate benefits would be small. It was, however, found that there were areas in which the cultivation of former padi land was limited by a shortage of labour or draught animals or by the difficulty of bringing back into production land which had been neglected and the practical experience gained during the laying down of agronomic trials under difficult conditions was of great value in organising tractor units for contract work in these places. These contract services, which were started by the Department of Agriculture but later undertaken by the Rural and Industrial Development Authority, increased rapidly until 1953, when 4,250 acres were mechanically cultivated (2), but have since declined, being gradually replaced by small commercial contractors who are able to operate more economically in their own district than a centralized official organization.

In 1953 the progress of the Department's programme was critically reviewed (1) and it was decided that, while the more promising lines of agronomic investigation would be continued, greater attention should be given to the possibility of introducing mechanised padi farms in the under–populated areas for which irrigation and drainage schemes were being drawn up by the Drainage and Irrigation Department. It was hoped that mechanisation would enable a family to cultivate a comparatively large acreage of padi, thus enabling them to enjoy a high standard of living and at the same time ensuring that a large proportion of the rice grown in these new areas would be surplus to local needs and available for general use in the Federation.

During the second phase of the Department's investigations, which is still continuing, priority has therefore been given to experiments into methods of mechanising all the operations necessary for the growing of rice, since in sparsely populated areas casual labour will not be available to help the farmer at peak periods; and to the economic aspects of mechanisation, since a

man will not learn new skills and invest capital in a new type of undertaking unless he is certain that he will enjoy a higher standard of living as a result of his enterprise. The final objective of this second phase of the programme is the opening of a pilot scheme where new techniques can be tested, costs determined under actual working conditions and the optimum size for a mechanised family holding established. Plans for this pilot scheme have been drawn up and, after many vicissitudes, the necessary funds have been obtained and a site in a new irrigation area approved: the site has been surveyed and a certain amount of preliminary work carried out but it is unlikely that irrigation water will be available until the 1956 season.

Although the development of a new system of mechanised padi farms has the highest priority in the present phase of the Department's programme, the needs of the existing wet padi acreas have not been entirely disregarded. Some of the methods which are now being developed such as, for example, the control of weeds by liquid sprays applied by cheap knapsack sprayers, may well prove useful in reducing the seasonal fluctuations in the labour required on a padi smallholding and a contract threshing service is already in operation in an area where casual labour is in short supply at harvest time. In addition to these off-shoots of the main lines of work a programme for the improvement ot local buffalo implements has been undertaken by the Department.

INVESTIGATIONS INTO THE CULTIVATION OF DRY PADI

The mechanisation of dry padi presents few technical problems and although, as in the case of wet padi, agronomic investigations were at first given high priority, complete mechanisation has been practised regularly since 1952, when a trailer-type combine which had proved unsatisfactory for wet padi work was allocated to dry padi investigations (4). Present investigations are confined to costing trials and experiments with cheaper and simpler harvesting machines but the main problem with dry padi is that, at the present Government support price, the cash return is insufficient to justify the capital cost of the essential machinery.

A REVIEW OF RECENT TESTS AND EXPERIMENTS

The Preparation of Padi Land

No important new techniques or modifications have been developed during the 1954 – 55 season but some interesting tractors have been tested on behalf of commercial firms. Among these were the American-made Economy Tractor, which is stated to have been successfully used for padi cultivation in the Philippines, and the British-made B.M.B. President, which has many interesting features including an optional hand-operated power lift offering the advantages of direct-mounted implements without the disadvantage of the high cost of a hydraulic lift: neither of these tractors were, however, found to be capable of doing useful work in existing padi areas in the Federation (3). Another interesting tractor submitted for test was the Platypus

Bogmaster (3), which was designed specifically for work on peat bogs and is fitted with very long and wide tracks giving a ground bearing pressure, under static conditions, of 1.3 lb. per sq. in. On mineral soils, which could be cultivated with standard wheeled tractors, the Platypus Bogmaster was particularly useful for final cultivations after the soil had been flooded and it was capable of pulling a 6 ft. Rotovator under adverse conditions: agronomic investigations have suggested that rotary cultivation is less satisfactory than conventional methods in that it may increase weed growth but the Bogmaster–Rotovator combination is capable of producing in one operation a satisfactory seed–bed from soft and flooded land and it would undoubtedly prove useful in wet seasons. The high cost of the Platypus Bogmaster (over three times that of a mass–produced wheeled tractor) would probably render it quite uneconomic on an individual holding or as a contractor's machine in existing areas but it might be justified in an area where the holdings had been laid out for mechanical cultivation and where a considerable amount of contract work could be obtained within a short distance of the contractor's base.

The Planting of Padi

No further work on the development of a padi transplanting machine has been undertaken and, although the progress made in Italy and other countries is being watched, it is considered that direct sowing of padi seed will be necessary for several years. Three types of drill, including a combine drill, have been used for planting dry padi but it has not been found possible to use drills on wet padi seed–beds because control of the sowing depth is very difficult in the soft soil and because the mud chokes the seed tubes. Hand–operated seed fiddles, carried by men walking across the field, have proved fairly satisfactory and three new types, one of which has a geared drive, have been obtained (3). It is hoped that the geared machine, which did not arrive in time for field trials, will give a more regular distribution of seed than the more conventional bow–driven type although it is clear that completely uniform distribution can never be obtained from a spreader which utilizes a spinning disc. Investigations are now being made to determine whether reasonably uniform seeding can be achieved by passing over the field several times in different directions so that the inequalities in the distribution are averaged out.

The detrimental effect of uneven seeding was clearly demonstrated in a trial in Kedah where the over–seeded areas were more seriously lodged than those which received too little seed: the plots were covered by 'waves' of standing and lodged padi which necessitated constant re–adjustment of the combine and consequently slow work at harvest time. There would be no great labour demand for other operation at planting time on a padi farm and the additional labour required for improved techniques, such as the multiple sowing mentioned above, would be justified if they resulted in a saving of time at harvest when there will probably be a shortage of labour even on the most highly mechanised holding.

The Control of Weeds

Mechanical control of weeds with steerage hoes is regularly practised in dry padi conditions but it seems unlikely that a tractor capable of accurate down–the–row work in wet padi will ever be built and mechanical weed control in the growing crop cannot be considered a practical proposition. Thorough cultivation of the soil before planting reduces weed growth in some circumstances, and careful manipulation of the water level around the growing padi may control certain types of weeds, but chemical control appears to be the only possible method of controlling all species in all seasons. An experiment in Kedah (3) has shown that liquid selective herbicides are effective and that they can be satisfactorily applied with a pair of knapsack sprayers and a simple boom but the dosage rates of the four herbicides which were used (1, 2 and 3 lbs. of acid equivalent per acre) were too high and the experiment is to be repeated at lower rates during the coming season The cost of the chemicals used varied considerably but the cheapest material, a liquid formulation of the potassium salt of M.C.P.A., cost on \$ 5[1] per acre (\$ 12.36 per hectare) when applied at the rate of 1 lb. acid equivalent per acre.

Harvesting

Experiments with various types of harvesting machinery have been given a high priority in the Department of Agriculture's investigational programme and a number of field trials were carried out during the 1954–55 harvest.

1. **Combine Harvesters.** Mechanical failures, which would have been merely inconvenient had spares been available but were very serious since new parts had to be made locally, delayed the 1954–55 trials with the Massey–Harris Rice Special combine and, although conditions were excellent, work was done on only 12 out of a possible 34 working days. A total of 20 acres (8.1 hectares) yielding 23.2 tons (23,571 kgs) were harvested in 52.7 hr., the working rate being low because the main part of the season was lost through breakdowns and the crops on the only sites available were overripe and badly lodged. The cost of combining was high, averaging \$ 53.61 per acre (\$ 132.47 per hectare) as compared with \$ 39.76 per acre (98.25 per hectare) during the previous season (5) and this higher cost, together with a fall in the Government support price for padi from \$ 17 to \$ 12 per pikul (from 28 to 20 cents per kg.), increased the relative cost of harvesting to about 26 per cent of the value of the crop as compared with 15 to 20 per cent in the previous season (2).

2. **Reaping.** Although scythes are not normally considered suitable for rice harvesting because losses through grain shattering are unduly high, (6) a light, soft steel scythe with a cradle, which was obtained from Austria through the Agriculture Division of the food and Agriculture Organization of the United Nations, was tried in Malacca. The reapers were not accustomed to using scythes and did not acquire much skill, with the result that time was wasted in preparing

1 *All in terms of Malay dollars.*

the swathe for hand threshing, but they did not consider the work arduous and the scythe was very much quicker than the conventional sickle. Shattering was obviously severe but a simple experiment designed to compare the grain losses with those experienced when cutting with the sickle gave no useful information because the error was high due to rat and bird damage on the plots: a further experiment is planned for the coming season.

A new binder, the 4 ft. cut, tractor – mounted Bisset, was purchased during 1954 but arrived too late for proper testing under wet padi conditions. In a short preliminary trial under difficult conditions on peat soil, however, the Bisset showed great promise even though the plants were not firmly rooted and tended to be pushed over before the stems were cut by the reciprocating knife. The binder was successfully used in a dry padi area in East Pahang and an average working rate of 2 hr. per acre (4.9 hr. per hectare) and a cost of $ 16.34 per acre ($ 40.39 per hectare) were recorded, the cost of twine being only 7.5 per cent of the total cost. After the crop was cut the sheaves were stooked and left for one or two days before being threshed *in situ* by a mobile thresher: the stooked sheaves were not damaged by rain and stooking required only 8 woman hours, costing $ 1.92, per acre (19.8 woman hr., costing $ 4.74, per hectare).

3. **Threshing**. The Andro thresher again gave high outputs in wet padi trials in Kedah and Malacca. In one trial, for example, the output was 194.8 lbs. (88.3 kgs.) per man hour, or about three times that achieved by conventional hand threshing, and the cost was $ 23.09 per 1,000 gantangs or about 4.8 per cent of the value of the crop. This is the lowest threshing cost that has so far been recorded by the Department of Agriculture.

The Andro thresher is mounted on skids and can be moved around the field to reduce the distance over which the crop has to be carried. In one trial the labour needed for carrying the crop was reduced from 33.3 to 19.8 woman hours per acre (82.3 to 48.9 owman hours per hectare) by threshing the crop *in situ* instead of carrying it to a central point. The Andro can be used to thresh padi which is reaped with the local sickle or with the *tuai* (a small knife held in the palm of the hand and used to sever individual heads) and it was found that the thresher with a crew of three men could easily keep pace with a gang of twenty women cutting the crop with sickles: the cost of reaping wet padi with the sickle and threshing with Andro averaged $ 95.44 per 1,000 gantangs or 22 per cent of the value of the crop.

A new thresher, the Rajah, was purchased during 1954 but did not arrive in time for the wet padi harvest. The Rajah is similar in design to the Andro but is larger and is intended for use in areas where tractors are used for cultivation. It is semi – mounted on a Ferguson tractor and can be used to thresh the crop *in situ*, the mechanism being driven by a shaft from the power–take–off shaft of the tractor so that no time is wasted in lining up belt pulleys when moving the machine from place to place. The Rajah thresher was

used to harvest dry padi in conjunction with the Bisset binder and, although the thresher has only about half the capacity of the binder, the trials suggested that a harvesting unit of three tractors, a binder and two threshers with a total crew of seven men and six women will be able to harvest 3 to 4 acres (1.2 to 1.6 hectares) of dry padi per day at a cost of about $150 per 1,000 gantangs or about 30 per cent of the value of the crop. The relative cost of harvesting wet padi would, however, be lower because the higher yields give a higher grain/straw ratio and thus more efficient threshing.

4. **Winnowing and Drying.** Although conventional methods of winnowing and sun-drying are adequate in existing areas, a large labour force would be necessary to deal with the output of, say, a combine harvester by these simple methods and suitable mechanical equipment is an essential prerequisite to the establishment of padi farms in underpopulated areas. Investigations with a cleaner and with a simple ventilated bin installation which utilizes the waste heat from a small engine to reduce the relative humidity of the drying air have been started and good results have been achieved in preliminary trials.

DISCUSSION

The Department of Agriculture is in a position to attempt the complete mechanisation of both wet and dry padi cultivation but further studies on the reduction of costs and the balance of investment in, and output of, machines for different operations are necessary. At the present time, for example, the only harvesting machine which can be confidently recommended for all conditions is the self-propelled combine but a machine of this type may cost $25,000 and represent an investment of nearly $200 per acre (nearly $500 per hectare) which is more than twice that required in tractors and cultivating implements. The promising results obtained with the Bisset binder and Rajah thresher are therefore important, since these machines would make use of the tractors necessary for cultivation and would make use of the tractors necessary for cultivation and would represent an additional investment of only about $45 per acre ($113 per hectare).

Even under the difficult conditions which are found in the existing padi areas of the Federation most aspects of padi cultivation can be mechanised but it is probable that only in exceptional circumstances will mechanisation be agronomically and economically sound. Some of the methods which are being investigated in connection with complete mechanisation, such as the control of weeds with selective herbicide sprays applied with cheap equipment, may, however, find a place in the agricultural system of these areas and, in conjunction with improved buffalo implements, may make the growing of padi a more profitable and less arduous occupation.

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SOIL SURVEY OF ESTABLISHED PADI GROWING AREAS OF THE KEDAH – PERLIS COASTAL PLAIN[1]

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INTRODUCTION

The Kedah–Perlis Coastal Plain, in the extreme north–west of Malaya, is some 50 miles long and varies from two to twelve miles in width. During the past 100 years or so, some 300,000 acres of the plain has been cleared of mangrove and swamp forest, drained to some extent by local labour and cultivated for padi, so that it now represents the largest single padi–growing area in Malaya. Yields of padi vary from less than 1,000 lbs. per acre to more than 3,750 lbs. per acre, the higher yielding areas being found generally within four to five miles of the coast. Recently a soil survey was started to assess the reason for this variation in yields, to enable systematic manurial experiments to be carried out on the different soils

1 This is a brief summary of the work; full details will be published elsewhere.

found, and to determine to what extent their yields can be economically increased by application of fertilisers.

METHODS OF SURVEY

Kedah experiences a much longer and more intensive dry season than any other part of Malaya. As a result, the regional water-table from January till April is generally 3 to 4 ft. below ground level. It is thus possible to examine and classify the padi soils of the Kedah—Perlis Plain according to observed differences in profile morphology. This is not possible in the padi areas further south.

In starting the present survey, a preliminary classification of the soils into 18 series was carried out by examination of some 80 pits dug at intervals along lines approximately five miles apart, running due east—west, i.e. from the higher lying ground, generally under rubber, in the east, towards the Malacca Straits in the west. On the basis of this classification, a reconnaissance survey was started with the assistance of the Field Staff of the Department of Agriculture, Kedah. These personnel were all inexperienced in soil survey, so to make maximum use of the available manpower, the following method of survey was adopted:

The more senior Asian members of the staff were trained in the method of describing a soil profile recommended in the United States Soil Survey Manual. They were then put in charge of teams responsible for aligning east—west compass lines one mile apart and for digging, describing, and sampling each horizon of pits at intervals of 1,000 yards along these lines. These pits were left open, subsequently to be examined by an experienced soil surveyor and classified according to the preliminary classification. This classification was found to require only slight adjustment in order to include all the soils found. With five or six teams working it was not found possible for one surveyor to examine and classify all the pits in the field. However, aided by the pit descriptions (recorded on standardised tables by the various team leaders) and the samples taken from each horizon of the various pits, it was possible to classify with confidence the pits (about 1/3 of the total number dug) which had not been classified in the field. In this manner an area of some 150,000 acres was mapped on a reconnaissance basis during the 11 weeks of field work. Accurate descriptions of every pit examined were kept for future reference, and samples from each horizon of these pits were taken for laboratory analysis. In addition, a start was made on detailed field mapping using an 18 in. diameter, tractor—powered post—hole auger for locating soil boundaries. It was found that a bore—hole with an auger of this diameter was more rapidly made than one with a hand auger, and, in addition, exposed sufficient profile face to enable the soil to be more easily and reliably identified. When any difficulty arose in identification of the soil, two holes were sunk side by side and the separating wall dug out with a changkol, thus constructing a pit approximately 4 ft. long by 18 in. wide by 36 in. deep, which made complete examination of the profile feasible. The main adventage of the method lies in the greater rapidity of digging; whereas a pit large enough to permit complete examina-

tion of a soil profile would take two men about 45 minutes to dig, a similar pit could be dug by the tractor–driven auger in less than 10 minutes. A single 18 in. diameter hole, generally found sufficient to permit soil identification, could be dug to a depth of 36 in. in something like two to three minutes. Soil series boundaries were followed by boring holes at intervals of 250 yd. in a rectangular progressive pattern. Points at which the series boundaries were located were marked directly on to aerial photographs ($2\frac{1}{2}$ in. to 1 mile) of the area under survey. It was found that soil boundaries, in general, could not be inferred with certainty from any indications on the aerial photographs, so that every boundary had to be followed out completely on the ground. The tractor–driven auger method seems to be the speediest method of doing this in large areas of dry, open country.

BRIEF DESCRIPTION OF SOILS

In the surveyed area ef the Kedah–Perlis Plain, 18 soil series were mapped; these can be placed into six groups on a basis of their mode of formation as follows:

1. **Marine soils**
   Series: Kuala Kedah; Tebengau; Kampong Sedaka; Pengkalan Kundor.

2. **River Levee Soils**
   Series: Telok Chengai; Telok Kechai; Sala Kanan; Derga; Kampong Titi Idris.

3. **Inland 'Basin' Soils**
   Series: Guar Kepayang; Alor Belat.

4. **Creek Soils**
   Found at Dulang, Sala Kanan and at many places along the coast. Not classified as series.

5. **Soils Influenced by Kedah Peak**
   Complex: Yen.
   Series: Dulang.

6. **Inland Colluvial and River Valley Alluvial Soils**
   Series: Hutan Kampong, Lepai, Tobiar.

Marine Soils

These have been laid down as alluvium under marine conditions. The building up of alluvium seems to have taken place gradually in an outward direction from the original coast line rather than by formation of a series of "lagoons". This is suggested because there is no extensive development of peat basins, and a definite sequence of development of a mature soil profile can be traced from one series to the next. This applies in particular to the Kuala Kedah, Tebengau and Kampong Sedaka Series, which form three strips parallel to the present coast line, each representing a stage in mature profile development.

River Levee Soils

Typical river levee soils are found surrounding the drainage systems of the Kedah and Perlis Rivers and also, to a lesser extent, the other smaller river systems traversing the Plain. These soils are characterised by their well–developed crumb structure, red mottling and red iron oxide deposits (which in some of the inland levee soils extend to depth of more than

6 ft.), and by the relative lightness of their texture. The development of these soils falls into two phases. The recent levee soils–Telok Chengai, Telok Kechai and Sala Kanan Series–occur on the estuary of the Kedah River and represent the tidal levee phase, during which the river floods its banks at every exceptionally high tide, leaving behind rather fine-textured sediment deposited in a saline medium. The older levee soils–Kampong Titi Idris and (probably) Derga Series–represent the "seasonal" levee phase when the river overflows its banks in its upper reaches only during seasonal, heavy rainfall, leaving behind on the banks texturally graded deposits (which, close to the banks, may be very coarse) laid down in a non–saline medium.

Inland 'Basin' Soils

These are distinct from the river levee soils in that they have laid down during seasonal floods, not parallel with the river banks but within low-lying "spill-ways" in the general surface of the older alluvium, e.g. old river courses, natural drainage channels, and shallow depressions of any nature. The deposits are partly material deposited by flood water and partly wash from the surrounding alluvium. The soils are low-lying and poorly drained, generally silty or loamy in texture, dark in colour and the subsoil is frequently sulphurous, darkening on exposure to air. Structure is mainly coarse (blocky or prismatic); heavy, powdery or smooth continuous iron deposits occur along structure faces. Padi growth is generally very poor in these areas, and frequently no attempt has been made to bring such areas under cultivation.

Creek Soils

These soils occur as elongated, often multi–branched deposits near sea. They are presumed to represent old drainage channels which gradually silted up as their discharge rate became impeded through accumulating alluvial deposits at their mouths. Frequently a whole system of such silted–up channels exists in one area, all of which are liable to be flooded by sea water, often via local, still functioning channels, where an exceptionally high tide, or a high tide accompanied by heavy rainfall, occurs. The soil is a silt, dark grey in colour, massive in structure, generally highly saline, and alkaline in the lower horizons. It is generally unsuitable for padi cultivation.

Soils Influenced by Kedah Peak

Yen Complex. This name has been given to a group of soils which owe their nature directly to the influence of Kedah Peak, a mountain of 4,000 ft. which forms the southern limit of the Kedah-Perlis Coastal Plain. The regular, heavy, local rainfall has given rise to wet conditions suitable for development of peat, small basins of which, up to 5 ft. deep, occur at the foot of the mountain. A thin layer of peat, now largely burnt off, at one time covered the whole area for three or four miles north of the Peak. The heavy rainfall has also caused deposition of large amounts of loamy, colluvial material on top of the local marine

alluvium. This process, as well as giving rise to a characteristic light-brown, loamy topsoil, has buried considerable quantities of organic matter, giving rise to an acidic sulphurous subsoil which rapidly blackens on exposure to air and becomes white on digging. The embedded organic matter also appears to be responsible for a greatly increased mobility of iron within the soils of he area, since heavy slimy iron deposits are left in drainage canals when the water table falls in the dry season. In addition to the peat and 'buried organic' soils in the Yen complex there is a soil consisting of sticky, structureless, light-blue to white clay containing some undecomposed wood and overlain by a thin layer of the powdery, loamy topsoil which occurs widely over the whole area. The origin of this clay, which extends to a depth of more than 6 ft., is not known; it appears to occur only over a limited area. The peatier soils, which contain a variable percentage of loamy hill-wash are extensively cultivated by Chinese market gardeners. Padi yields appear to be low.

Inland Colluvial Soils and River Valley Alluvial Soils

These soils are generally sandy loams and have an indurated lateritic layer at a depth of 4 to 5 ft. They do not have the deep, black topsoil found in the soils nearer the coast. The classification of these soils is not yet complete. The Hutan Kompong and Lepai Series belong to the Inland Colluvial group, and Tobiar to the River Valley Alluvial group. These are amongst the lowest yielding soils in Kedah,

SUMMARY

A description has been given of the methods employed in a reconnaissance soil survey which was recently started on the Kedah-Perlis Coastal Plain. A brief description of the soils encountered has also been given.

INSECT PESTS OF THE RICE PLANT IN MALAYA

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INTRODUCTION

Approximately 95 percent of the 845,000 acres under padi in Malaya is wet padi so that hill or dry padi occupies only a minor place.

As practically all the Malayan padi insects are identical with those found elsewhere in South-East Asia, detailed descriptions of the species concerned, their life cycles, and their parasites and alternative hosts are not given here especially as particulars of most species have been published by Pagden (10 – 13) and later reviewed by Logothetis (6) in a paper presented at the Second Working Parties on Rice Breeding. The report of the Sixth Entomological

Conference of 1954 (14) also includes a large amount of information. The present paper attempts to deal with all the local insect pests of padi; no single article exists with the recently accepted names and notes on all the species found here.

Insect pests of growing padi can conveniently be divided into three main groups of : (I) stem-boring caterpillars, (II) sucking bugs and (III) leaf-eating caterpillars. A number of other insects (grasshoppers, crickets, thrips, beetles and flies) and red spiders also cause some damage but this is usually almost negligible compared with the three chief categories mentioned; these are briefly treated as section IV.

I. STEM-BORING CATERPILLARS

A. Local Species

Five species occur but only four are of any consequence – three are Pyralids (Subfamily Crambinae) and one Noctuid. They are all the larvae of moths which lay eggs on the leaves or inside the leaf-sheaths of the plant, the stem being bored by the emerging caterpillars, which subsequently pupate therein or outside at the base. As the caterpillars develop they descend inside the stem and the injury increases progressively, often involving the grain so as to cause empty 'white ears', except in the case of *Sesamia*. The caterpillars, by reason of their concealed habits, are very difficult to control and the percentage damage to stems, which varies from light to heavy, is also difficult to evaluate. McNaughton (7) deals with this question and shows that for South-East Asia 10 to 20 per cent loss of crop is an acceptable figure which agrees with information obtained in 1951/52 locally from the various States and Settlements. Perak usually has much heavier damage than Malacca and Nagri Sembilan.

Until quite recently there was much confusion over the nomenclature of padi stem-borers which has been subjected to tantalisingly frequent changes which have fortunately now been clarified by Jepson (5).

The first species is the yellow stem-borer, *Schoenobius incertulas* (Walk.) which was previously referred to either as *S. bipunctifer* (Walk.) or as *S. incertellus* (Walk.) The eggs, covered with scales from the body of the female moth, are almost always laid on the upper surface of the leaf; Logothetis' (6) statement based on literature that it is mainly on the lower epidermis does not hold good for Malaya.

The complete life cycle occupies about 7 weeks of which 5 are spent as the larval stage.

No alternative host plants have so far been recorded for *Schoenobius* which is of interest as moths have been taken by the writer by day at Fraser's Hill at an elevation of 4,500 feet and by artificial light near the coast at Port Dickson – both localities many miles from any growing padi areas – probably these moths flew in from small areas of volunteer, i.e. self-sown or regrown, padi.

Another species, *S. dodatellus* Walk., occurs but is usually a minor pest and is merely mentioned here for reference.

The second economic species, *Chilotraea polychrysa* (Meyr.), was until recently referred to as *Proceras polychrysus* Meyr.,

before that as *Diatraea polychrysa* Meyr. and still earlier as *D. auricilia* (Dudg.). The genus *Diatraea* is strictly neotropical and so does not occur anywhere in Asia. No popular name seems available for *Chilotraea* but the writer suggests that the dark-headed striped borer, like its very dark brown-headed larva with greyish-lilac stripes, is easily distinguishable from the pale-headed rice borer (*Chilo*) with brown stripes, to be described next.

Although *Chilotraea* is only mentioned by name in the report of rice insects of South-East Asia for the Second Working Party (6), yet it is the most serious padi pest in Malaya. Its larvae have been reared from the sedges *Scirpus grossus* and *Cyperus digitatus* and of the grasses recorded by Pagden (11), *Oryza latifolia* is now probably *O. sativa* var. *spontanea* and *Setaria rubiginosa* is now *S. geniculata*. It was also reared in 1930 from *Panicum amplexicaule* (formerly *Hymenachne myuros*).

The Eulophid parasite *Cirrospilus* sp. near *ingenuus* Gahan, attacks the larvae and emerges from the pupae. This parasite was identified from material taken in 1949 and sent to the Imperial Institute of Entomology and is probably identical with the Chalcidoid parasite referred to earlier by Pagden (10).

The hypopus stages of a Tyroglyphid mite (? *Caloglyphus*) were found in 1951 on the anal segments of healthy larvae but these are not parasites but scavengers.

The third Pyralid, *Chilo suppressalis* (Walk.), was previously recorded as *C. simplex* (Hamp.) and is referred to by Jepson (5) as the striped rice borer, a name which could equally apply to *Chilotraca*; — the writer suggests for *Chilo* the more exact name of the pale-headed rice borer. For many years this species was, owing to its very similar appearance, not separated from *Chilotraea*.

A larval/pupal parasite is *Cirrospilus* sp. near *ingenuus* Gahan and the Tachinid fly *Sturmiopsis semiberbis* Bezzi is a true larval parasite.

The last species of stem-borer is the Noctuid, (sub-family Agrotinae), *Sesamia inferens* Walk. a much more robust moth than any of the previously mentioned Crambines. It is popularly called the violet stem-borer, though not so mentioned in Jepson's table (5); it is only listed by name in Logothetis' bibliography (6). 'A characteristic blue powdering is present on the anterior end of the pupa.

As in *Chilo*, the larva develops in 6 weeks, the complete life cycle takes about 8 weeks. Generally it is a less important pest than the Crambines but can do serious damage and was reported as long ago as 1887 (15): injury is confined to the leaf-sheaths and stem but 'white ears' are not caused.

Sesamia has a very wide range of host plants and is frequently found in sugar cane and maize (especially the former) as well as in the sedges *Scirpus grossus* and *Cyperus digitatus* and a large number of grasses (11) including *Paspalum orbiculare* which is now named *P. scrobiculatum*.

B. General Information

There is a wide variation in the dominance of the different species of stem-

borers both in the same locality in different months of the year, in different years and in different localities in the same year. Thus in one area in Province Wellesley there were the following variations in relative numbers of larvae in March compared with the previous November:

> *Schoenobius* 13 times as numerous, *Chilo* one–fifth and *Sesamia* no less than 43 times the numbers present four months earlier.

Reference is here made to an interesting and apparently overlooked article by L. Wray (15), the Curator of the Perak Museum, who as long ago as 1887 gave what must be the first report of local stem–borers — *Chilotraea polychrysa* (referred to then as *Chilo*) and what is clearly *Sesamia*, though the moth was not named by Wray.

In Malaya, unlike Japan, there are no periodical emergences of moths from which outbreaks can thus be forecast as all stages of stem–borers are present throughout the year. There is, however, a regular fluctuation in numbers irrespective of the abundance of the fool plant (11, 13). Attack during the first month after transplanting has little effect on yield, the second month being the most critical. It was also found pre–war that padi sown in May and June gave a more consistent yield than when sown at any other time, particularly between January and March and October to December when yields were very low (3).

Control by flooding, crop rotation and collection of eggmasses are not practised in Malaya and the use of light traps is considered too uncertain. Good results, however, were obtained in Kelantan by suspending the lamp over a board smeared with 20 parts of liquid rubber heated with one part of latex. This captured a much larger number of moths than the conventional bowl of water with a kerosene film placed under a lamp.

C. Biological control

During 1931–32 attempts were made to control stem–borers by mass production of the egg parasite *Trichogramma japonicum* Ashm. Although the figure of a million parasites bred per day was reached and liberation of 1,300,000 parasites per acre was made, yet this was not an economically practical method (12).

The introduction of Tachinid flies from South America was under way in 1939 but was interrupted by the war and could not be resumed until 1951 when trial shipments of pupal *Paratheresia claripalpis* v. d. Wulp were started from Trinidad. It was then found possible to inoculate larvae of *Chilotraea polychrysa* and *Chilo suppressalis* with the minute maggots emerging from the flies which are larviparous. Of the total puparia, 70 percent, totalling 8,187 flies, were released during 1952. It was found, however, that liberation in the field of flies emerging from puparia was a better method than laboratory breeding from inoculations of caterpillars. Small numbers of another neotropical Tachinid fly, *Metagonistylum minense* Towns., had been sent in 1951 but this insect proved delicate and was not successful. Searches in the double–cropping area in Province Wellesley, where all the releases of *Paratheresia* were made, have so far failed to recover any Tachinid flies.

D. Chemical control

Tests in 1948 indicated that although 5% DDT, 0.65% gamma BHC and 20% toxaphene dusting in the nursery all lowered borer damage, the residual effect of these insecticides was not long enough to prevent infestation after transplanting. Spraying with Parathion and TEPP at 1:1000 were not successful and soaking seedlings in Parathion at 0.025% also failed to prevent subsequent damage in the field.

The systemic EPN 300 was tested on a small scale at ½ lb. active ingredient per acre but it was decided that its high toxicity to mammals ruled it out for local use. Dieldrin and endrin, also at ½ lb. actual per acre, were found unsuitable on the grounds of very high toxicity, especially endrin, to ducks and fish which form a source of food in all padi areas. Unpublished results obtained by Mr. I.J. Wyatt indicate that the time of application of the spray is most important, the optimum period being about 6 weeks after transplanting. Applications at 4 or 5 weeks and particularly 9 weeks after transplanting are ineffective in checking attack. These were pot experiments with the variety Pebihun.

II. SUCKING BUGS

Two main types occur, viz. the larger unequal-winged Heteroptera, feeding either at the base of the stems or on developing grains, and the much smaller equal-winged Homoptera or plant-hoppers which may occur in very large numbers on young padi plants.

A. Heteroptera

Leptocorisa acuta Thnbg. so-called padi "fly" of South-East Asia, better known locally as the green padi bug. It migrates from various wild grasses to feed on padi at the milk stage, resulting in empty or partly empty grains. Full details of this insect appear in a bulletin by Corbett (1) where, however, the complete development from egg to adult appears in one section as lasting for 16 to 17 days and later on as 26 to 27 days (comprising 6 to 7 days for the egg and 20 days for the nymphs); the latter figures are the correct ones. An unidentified Chalcid egg parasite, from Selangor and Negri Sembilan is mentioned by Corbett as developing in 11½ days (1); it has since subsequently been identified as the Encyrtid *Ooencyrtus malayensis* Ferr. Another egg parasite, the Sceilonid *Hadronotus leptocorisae* Nixon, was taken by the writer in Kelantan early in 1955; it develops in 13 to 14 days. Although described from Java in 1934 it had not previously been recorded from Malaya. Unfortunately these parasites do not check *Leptocorisa* efficiently though a parasitism rate of 26 per cent has been recorded for the *Ooencyrtus* (1).

Until recently there was no adequate control for *Leptocorisa* although the traditional use of dry coconut fronds carried as torches, plus lamps, by night through the fields is reported as killing large numbers. In conjunction with this, the use of nets, palm or bamboo framework on poles and ropes smeared with various kinds of latex is often practised by cultivators but are cumbrous and not usually effective methods. Grist (4) states carrion baits are much used but this is not now a very widespread practice. Planting of varieties with the same maturation period at the same time shortens the time when inflorescences occur.

Although cultivators are aware that *Leptocorisa* flourishes in wild grasses, it has proved difficult to have dense stands of these cut down even around padi areas although this measure has been advocated.

Dusting with 0.65 % BHC by means of rotary dusters gives local but only partial control as many insects fly off ahead of the cloud and reinvasion into the padi soon follows.

With the appearance of a portable fogging machine, the "Swingfog", it became possible to lay down a sufficiently heavy fog to reach the insects when disturbed by the operator. The first test in Malaya, carried out in Kelantan in January 1955, with one part of 25% DDT concentrate to three parts of Sovacide PYD was used for fogging at an average rate of ½ gallon of the mixture per acre, this taking ½ hour. Results were very satisfactory and a small scale test showed that 47 per cent of the adults collected in the fogged area were dead or moribund compared with only 9 per cent in an unfogged area. Fogging is best carried out from 7 to 8 a m. though on overcast days it can continue till 10:30 a.m.

Although four other species (*L. varicornis* F., *L. costalis* H. Sch., *L. corbetti* China and *L. lepidu* Boisd.) occur in Malayan padi fields, practically all the damage is done by *L. acuta*. This species is confined to Asia though McNaughton (7) includes Australia and the Pacific Islands as localities where it occurs but this is due to confusion with *L. varicornis* which extends from Queensland to Fiji and Tonga.

Minor Coreid pests are *Cletus punctiger* Dall., *C. trigonus* Thnbg. and *Riptortus linearis* F., all found in the stems and ears.

The next group are the shield bugs; *Scotinophara coarctata* F., the black padi bug, feeds chiefly at the base of the stems and causes severe injury to the panicle, sometimes resulting in death of the plants when present in large numbers. In droughts these bugs shelter in cracks in the soil and are then often a serious pest resulting in stunted plants with reddish–brown leaves. When irrigation from reservoirs is possible there is usually less damage than when the water supply is from rainfall. Details of the habits published in 1924 (2) show that the life cycle occupies 32 days. The sedges, *Scirpus grossus* and *Scleria sumatrensis*, and the grass *Panicum amplexicaule* (formerly *Hymenachne myuros*) act as additional host plants.

The formerly unidentified Chalcidoid egg parasite (2) is *Telenomus triptus* Nixon parasitising up to 55 per cent of the eggs. A second Scelionid parasite, *Microphanurus artabazus* Nixon, has been bred from eggs of an undetermined species of *Scotinophara* and can be expected to oviposit in those of *S. coarctata*. These records have not hitherto been published.

Considerable control of the black padi bug can be obtained by flooding the fields for 2 or 3 days; ducks are well known to search out and eat the bugs at the base of the padi. Nowadays dusting with equal parts of 5 % DDT and 0.65 % gamma BHC is usual and exerts a good check, each insecticide by itself gives a low mortality to the insects.

The mixture gives better results against the adult than the nymphs.

With the interest now being taken in portable fogging machinery it is hoped that DDT or BHC in oil in the form of a fog will reduce damage by this bug to a low order.

Two other species, *S. bispinosa* F. and *S. cinerea* Le Guill., also occur in padi but cause only slight damage compared with *S. coarctata* F. Neither Logothetis (6) nor McNaughton (7) includes this economic species, referring only to *S. lurida* Burm. of Ceylon. This bug is also found in Japan and has been recorded from Malaya at light.

Minor injury is caused by two larger Pentatomids; *Tetrods histeroides* F. whose economic status is considerably less in Malaya than *Scotinophara*, the reverse to S. India. It occurs on lalang (*Imperata arundinacea*) as well as on padi. The second species, *Dinidor obscura* Lep. & Sev., has been reported as a nursery pest only in Kedah. Common enough on ears and stems of older padi are *Nezara viridula* L., *Antestia degenera* Walk., *Menida varipennis* Westw. and *Eusarcoris ventralis* Westw.; they are all of but little importance

B. Homoptera

The Delphacid *Sogata furcifera* (Horv.), formerly referred to as *S. pallescens* Dist., is a small grey plant-hopper often present in enormous numbers on padi plants where it sucks sap from the stem just above water-level except in the early morning when it feeds higher up. Severe attack results in a well-defined yellowing of the leaves not to be confused with the reddish colouring, a condition known as "penyakit merah" which often occurs without the presence of the plant hoppers. The insects also occur on the grass *Digitaria didactyla*.

Dusting with 5% DDT at 20 lbs. per acre is now the accepted method of control though often supplemented by the pre-war treatment of draining off the water for 2 or 3 days. *Sogata* has been reported to cause severe damage when the water is stagnant and it has never been observed in any numbers in dry areas (8).

The Jassid *Nephotettix bipunctata* F. is a smaller plant hopper with green wings tipped with black. It also occurs abundantly on padi plants and severe attacks have been recorded since the war in the double-cropping areas in Province Wellesley and Penang. It appears to be less dependent on wet conditions than *Sogata* and, like it, is now controlled by means of 5% DDT dust. However, as mentioned previously under the Heteroptera, it is likely that fogging will soon supplant all other methods for controlling padi bugs in the field. The specific name *apicalis* Motsch. had previously been used and is now adopted in Japan (9).

The only other Homoptera is another Jassid, *Erythroneura* or *Typhlocyba* sp., which is mentioned here on account of the characteristic white flecking caused on the young leaves.

III. LEAF-EATING CATERPILLARS

Injury is caused either by straightforward consumption of the leaf as it grows or,

after cutting and folding or rolling of the leaves, by eating the tissue.

A. Army worms and cutworms

Spodoptera mauritia Boisd. is the worst of the swarming caterpillars attacking padi in the nursery. Very severe damage can be caused as the caterpillars migrate from field to field and frequently are not noticed in the early stages when the leaf tips are only scraped before the leaf blade is consumed.

Early dusting of the young caterpillars with 5 %, or even 2½, DDT at about 25 lbs. per acre gives good control. One lb. of the dust will treat a nursery of 20 gantangs of seed. It was found that with wood ash used as a diluent the injured nurseries recovered quicker than with talc; best results were obtained in hot sunny weather. In the field it may be a pest of dry padi.

This use of DDT has almost superseded by watering with tuba (derris) which kills even late instars (fifth and sixth) of this insect. Sprays of DDT – wettable powder or miscible concentrates (.1 % active ingredient) – can be used instead of the dust but in all cases early action is important.

S. mauritia Boisd. has been bred from padi and the closely related *S. pecten* Gn., which is also a minor pest of padi, occurs on *Paspalum scrobiculatum* and maize.

A point of considerable interest is that while the army worm, *Leucania unipuncta* Haw., (formerly refered to the genus *Cirphis*), can be a serious pest on *Pennisetum purpureum* and *Axonopus compressus* in Malaya, yet it has never been recorded here as a padi pest, unlike U.S.A., Hawaii, India, Japan and Formosa.

Other Noctuids are *Laphygma exempta* Walk. *Borolia venalba* Moore and the semi–looper *Mocis frugalis* F., which are all occasional pests of padi and various grasses; *Laphygma* also attacks a number of secondary crops.

B. Leaf–rolling and leaf–tying caterpillars

Damage to half–grown padi is fairly regularly reported in the form of bent back leaves accompanied by a loss of tissue due to feeding of larvae of *Cnaphalocrocis medinalis* Guen. Demage may become severe if neglected and can sometimes be checked by early hand–picking of the easily observed rolled leaves though DDT or BHC sprays have also been used. This insect is not mentioned in the useful supplement of Malayan padi pests prepaerd by McNaughton (7) and is erroneously described by Grist as boring in the stems (4).

Three species of skipper larvae feed on the leaves at night hiding by day in a tunnel or groove formed by spinning together the opposite sides of the leaf. *Pelopidas mathias* F. (also listed as *Chapra*, *Parnara* or *Baoris*) and *Parnara bada* Moore are dark brown moths with yellow spots while *Telicota augias* L. is much smaller and paler. The larvae are normally kept in control by the Tachinids *Halidaya luteicornis* Walk. and *H. rufa* Bezzi and by the Braconid *Apanteles baoris* Wilksn. . If spraying is

necessary, DDT is recommended but damage usually occurs only in small patches.

The last lepidopterous pests in this section to be described are the case worms *Nymphula depunctalis* Guen. and *N. fluctosalis* Zell., semi–aquatic larvae with tufts of filamentous gills. These insects may become serious pests in the nursery as they crawl up the plants, cut off portions of the leaves and fold them into cases in which they shelter while feeding. When feasible, draining will kill them as they depend on oxygen dissolved in the water. No parasites have been recorded.

With all of the above insects, it is most likely that the use of insecticidal fogs liberated from portable pulse–jet machinery will soon be the usual treatment.

C. Other leaf–eating caterpillars

The light green caterpillar of the butterfly *Melanitis leda* L. *ismene* Cr. has a pair of red horns on its head and slender paired processes posteriorly. It is a nocturnal feeder and attacks rather mature padi as well as sugar cane. However, its damage is usually well checked by the Chalcid *Brachymeria daesaensis* Cam. Larvae of the Lymantriid *Laelia suffusa* Walk., were first recorded as a pest in 1925; they have characteristic tufts of hair. It also feeds on maize and various grasses.

IV. MISCELLANEOUS MINOR PESTS

The Bombay locust, *Patanga succincta* (L.), is placed in this section as only occasionally is it a pest and then it is confined to hill or dry padi areas. This insect does not behave as a true locust with swarms of hoppers but instead adults fly in from the jungle and attack newly opened up areas of padi.

In the event of a report of damage being received, spraying with dieldrin at ½ lb. of active ingredient per acre is recommended which is obtained by using 1 quart of Dieldrex 15 in 100 gallons of water, i.e. a dilution of 1:400. Otherwise, poison baits made with 1 lb. of either 5% DDT, 2.6% gamma BHC or Paris green in 24 lbs. of rice bran (14).

A detailed account of this pest has been prepared for publication by Mr. H.T. Pagden and the above notes should serve for this report.

Less important are two other genera of grasshoppers viz. *Atractomorpha psitticina* Hav., *A. crenulata* F., *Oxya chinensis* Thnbg., *O. diminuta* Walk., *O. intricata* St. and *O. velox* F. *Atractomorpha* always lays its eggs in the soil and *Oxya* usually in a mass among the leaf–bases: species of the latter genus are also recorded from the grass *Eleusine indica*.

The rice thrips, *Thrips oryzae* Williams, is chiefly a pest of seedling rice on which it causes apical leaf rolling and withering, sometimes resulting in the death of the plants. It is usually only severe during drought. Spraying with dieldrin at 0.035% active ingredient has given control in pot trials.

The larvae of two species of Languriid beetles – the smaller brown *Anadastus filiformis* F. and the larger *A. scutellatus* Cr. with blue–green wing cases – injure the upper

portion of the stem. Under west coast conditions, early planting lessens the damage.

The minute leaf-beetle *Chaetocnema basalis* Baly in Malaya takes the place of the larger *Lema* in Japan and Korea — damage is not severe and DDT has been recommended. Larvae of the spiny *Hispa armigera* Oliv. gnaw parallel lines and later mine between the leaves of young padi causing discoloured patches and withering of the leaf tips.

Small pink larvae of a midge *Chironomus* sp. near *oryzae* Mats., have been found at the base of stems of recently transplanted padi plants which had an unthrifty appearance. It is a serious pest in Japan.

The padi seedling fly, *Atherigona oryzae* Mall., is a pest of hill padi in the seedling stage when penetration of the leaf sheath followed by boring of the central shoot frequently causes death. Dusting with BHC is effective but is uneconomic as it requires to be done daily for one week after the seedlings appear above the ground.

The red spider, *Tetranychus oryzae* Hirst., injures the leaves of seedling padi which shows wilting and discoloration. The white cast skins of the mites are characteristic. Small outbreaks can be checked by spraying with Aramite at 0.2%.

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REVIEW OF THE "REPORT OF THE JOINT UNITED KINGDOM AND AUSTRALIAN MISSION ON RICE PRODUCTION IN CEYLON – 1954"

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and

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This is an interesting and thorough-going report of 54 pages on the problem of increasing rice production for home consumption in Ceylon. The report begins with a discussion of the background, taking into account the steps already taken by the government of Ceylon for the promotion of rice production increase as well as the studies in progress, and ends in a number of recommendations for further improvement.

Rice is the staple food of the people of Ceylon, but the country has never been self-sufficient in its food production. Before World War II, Ceylon used to import over half a million tons of rice from Burma. At that time the supply was always ample and the price was cheap. But after the War, the situation has changed. Due to the general shortage of food supply in the post war years, the rice price has gone up tremendously. In spite of all government efforts to increase food production, Ceylon at present imports about 460,000 tons of rice and 250,000 tons of wheat a year, at a total cost of over Rs. 450 million annually.

The standard of rice cultivation in Ceylon is generally low and it is cultivated in smallholdings, averaging 0.78 acre each. Owing to the population pressure on land, frequently as many as eight or ever more co-owners cultivate a field in rotation. This will mean that none of them is interested in improving the land and extension work may have to start afresh each season as the occupier changes." Furthermore the tenancy is often auctioned each year so that there is no security beyond a single crop. There is no inducement to improve the land. The other obstacles to rice production increase are listed as lack of reliable title to land, rural indebtness, stray cattle and interference from *chena* operations.

It is against this background that the government has been devising ways and means to increase rice production, such as improving acre yield and bringing new land under cultivation in the Dry Zone.

Production figures of food crops in Ceylon are unreliable as they are reported by village headmen. In general the past estimates of production have been very understated, while acreages reported overestimated. A resent statistical survey indicated that the actual yields of rice crop were about 70% higher than those reported by the village headmen.

Out of a large number of recommendations made by the Mission for the increase

of rice production in Ceylon, four are of general interest and will be stressed here.

The Mission recommended the establishment of a Rice Improvement Unit within the Agriculture Department "to focus a much needed concentration of research activity on the cultivation of paddy including plant breeding, crop husbandry, soil surveys and paddy nutrition, pests and diseases, and related subjects". This recommendation was followed up by another Mission from the government of Japan early in 1955 to provide expert advice on the establishment of the Unit.

In addition to its general endorsement on the further study of the problems of mechanical paddy cultivation, the Mission stressed the importance of improving simple indigenous cultivation implements, which seem to be neglected in many other countries also at the present time.

There is much over-lapping of work and responsibility between the Department of Agriculture and the Department of Food Production which was created in recent years "to carry out government policy in food production work". The Mission wisely advised that "If either is to predominate the choice should be the Agriculture Department".

There has been a tendency in many countries of the region including Ceylon to promote senior research officers to administrative posts for higher pay so that they can continue to stay in the organization but this will be done at the expense of research. In this connection the Mission strongly recommended that special arrangements for salaries and for promotion for them should be made in order to enable them to continue in their specialized activities.

LIST OF ARTICLES PUBLISHED IN THE NEWS LETTER DURING THE YEAR 1955

A limited number of copies of most previous issues of the News Letter since its first publication in 1952 are still available. Those interested in obtaining copies should address the Executive Secretary, International Rice Commission, c/o FAO Regional Office, Bangkok, Thailand, indicating the specific number of the issues desired.

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1. Rice Breeding Program in Egypt, by M. A. Koshairy, C. L. Pan and Gad el Hak.
2. The Mechanical Cultivation of Wet Padi in Malaya, by E.F. Allen and D. W. M. Haynes.
3. Mineralizing Action of Lime on Soil Nitrogen in Water Logged Rice Soils, by C. T. Abichandani and S. Patnaik.
4. Seed Multiplication and Distribution Schemes in India, 1953.

5. Breeding Rice for Improved Milling and Cooking Qualities in the U. S. A., by C. Roy Adair.
6. Problems of Tilapia Culture in Rice Fields in Taiwan, by T.P. Chen.
7. Use of Rice Fields for Fish Culture in Thailand.

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8. Studies on Seed–Borne Microflora and the Effect of Seed Treatment of Rice in Malaya, by W. J. Cherewick.
9. Effect of Lodging on Yield in Rice, by M. Subbiah Pillai.
10. Distribution of Seed of Improved Rice Varieties in the U.S.A., by C. Roy Adair.
11. Progress Report on Rice Breeding and Seed Multiplication Works in Taiwan, 1954, by Peter Kung
12. Floating Paddy in East Pakistan, by A. Alim and J.L. Sen.
13. Preparation of Paddy Lands by Mechanical Means, by D.H. Duyf.
14. Review of the Book "Rice and Crops in its Rotation in Subtropical Zones", by Owen L. Dawson.
15. Review of the Book "Le Riz Auz Etats–Unis", by R. Craps.
16. International Training Centers on Soil Fertility and Rice Breeding.

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17. The Background to Rice Variety Improvement in Malaya, by L.N.H. Larter.
18. Rice Hybridization in Malaya, by F. B. Brown.
19. Soil Survey of Jungle Swamps for Padi Cultivation, by J.K. Coulter.
20. Diseases of Rice in Malaya, by Anthony Johnston.
21. Review of an FAO Development Paper "Factors Affecting Rice Production".
22. The 1955 Meetings of the two Working Parties of the International Rice Commission to be held in Penang, Malaya, 5-11 December.

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23. Rice Mechanization in the Federation of Malaya, by D. W. M. Haynes.
24. Soil Survey of Established Padi Growing Areas of the Kedah–Perlis Coastal Plain, by A.R. McWalter.
25. Insect Pests of the Rice Plant in Malaya, by R.J.A.W. Lever.
26. Review of the "Report of the Joint United Kingdom and Australian Mission on Rice Production in Ceylon – 1954", by C.W. Chang.
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